Reliability of HMB
Cigré report 2012
Till Matthies, PGHV-DI
Summary and conclusion

Details
- The report
- Background info
- Contributing utilities
- Definition of major failure
- Basic statements
- Quantities of HM-types delivered
- HMB reliability – Reflected in Cigré statistic
- Conclusion
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The “Final Report of the 2004 - 2007 International Enquiry on Reliability of High Voltage Equipment” of Cigré states regarding major failure (MaF) frequencies: “modern hydraulic drives show the same reliability as modern pneumatic or spring drives.”

By combining the studies results with own data about the deliveries of HM type mechanism (see Fig. 1 and 2) it can be derived:

ABB’s HM type operating mechanisms show significantly lower MaF frequency than other technologies
Summary and conclusion

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Cigré report and statistic 2012

The report


- Published October 2012
- Working Group A3.06
- The report consists of 6 Technical Brochures
- Regarding operating mechanism on Circuit breakers
  part 2 (TB 510) is the most important

It is a study on reliability.

„Only failures occurring in the four-year period 2004 - 2007 are included."

“The information has been collected directly and solely from the utility sector.”

The study is based on the returned data – 91 utilities from 28 different countries have contributed to the report.

“Major failures (MaF)” of the equipment were an important part of the survey.
To collect the data a questionnaire was sent to the utilities.

### Participation in the survey

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Contributing Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (2)</td>
<td></td>
</tr>
<tr>
<td>Austria (2)</td>
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<td>Bolivia (4)</td>
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<td>Canada (2)</td>
<td></td>
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<td>Croatia (6)</td>
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<td>Czech Republic (1)</td>
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<td>Denmark (2)</td>
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<td>Finland (1)</td>
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<td>Germany (3)</td>
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<td>India (17)</td>
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<td>Poland (8)</td>
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<tr>
<td>Portugal (1)</td>
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<tr>
<td>Romania (1)</td>
<td></td>
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<tr>
<td>Serbia (2)</td>
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<td>South Africa (1)</td>
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<td>Sweden (2)</td>
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<tr>
<td>Switzerland (3)</td>
<td></td>
</tr>
<tr>
<td>USA (2)</td>
<td></td>
</tr>
</tbody>
</table>

Participation in the survey. The number between the brackets gives the number of contributing utilities within each of the countries.

[Source: Part 1 - Reliability of High Voltage SF6 Circuit Breakers, Table 1-1]
**Cigré report and statistic 2012**

**Major Failure (MaF)**

**Definition**
- Definition in the study is according to IEC 60694:2002: “Common specifications for high-voltage switchgear and controlgear standards”
- A MaF prevents the switchgear to perform its fundamental function

**Examples**
- Examples are
  - Sudden loss of SF6-pressure
  - Sudden loss of oil pressure in hydraulic operating mechanisms
  - Breakage of spring in spring operating mechanisms, preventing the mechanism to perform on command

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A switchgear **major failure** is defined as “failure of a switchgear and control gear which causes the cessation of one or more of its fundamental functions. A major failure will result in an immediate change in the system operating conditions, e.g. the backup protective equipment will be required to remove the fault, or will result in mandatory removal from service within 30 minutes for unscheduled maintenance”.
Types of operating mechanisms in the survey

Assignment of HM type

Hydraulic and HM types

The Cigré study has no separate category for operating mechanisms with HM technology (like AHMA and HMB), but it includes them in „hydraulic (may include springs)“. Thus, the category „hydraulic“ covers

- classical hydraulic mechanisms (with external piping and gas tank)
- as well as HM-type mechanisms (without external piping and springs).

Link: Definition Cigré-Categories for operating mechanisms

| Table 2-74: Types of operating mechanisms for total population of circuit-breakers |
|---|---|---|
| Type of operating mechanism | Number of CB-years | Distribution % |
| Hydraulic (may include springs) | 71810 | 25,5 |
| Pneumatic (may include springs) | 61604 | 21,9 |
| Spring | 144897 | 51,5 |
| Other (magnetic, motor, etc.) | 2779 | 1,0 |
| Total | 281090 | 100 |

[Source: Part 2 - Reliability of High Voltage SF6 Circuit Breakers, Table 2-74]
## Distribution of MaF frequencies

### Subtitle

#### Distribution per type

<table>
<thead>
<tr>
<th>Operating mechanism</th>
<th>MaF frequency (per 100 CB years)</th>
<th>Results of hypotheses tests (in relation to the total population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Point estimation</td>
<td>Lower limit</td>
</tr>
<tr>
<td>1 : Hydraulic</td>
<td>0,19</td>
<td>0,16</td>
</tr>
<tr>
<td>2 : Pneumatic</td>
<td>0,13</td>
<td>0,10</td>
</tr>
<tr>
<td>3 : Spring</td>
<td>0,11</td>
<td>0,10</td>
</tr>
<tr>
<td>4 : Other</td>
<td>0,04</td>
<td>0,00</td>
</tr>
<tr>
<td>Total</td>
<td>0,14</td>
<td>0,12</td>
</tr>
</tbody>
</table>

[Source: Part 2 - Reliability of High Voltage SF6 Circuit Breakers, Table 2-25]

#### Distribution per manufacturing period

<table>
<thead>
<tr>
<th>MaF frequency (per 100 CB-years)</th>
<th>All countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period of Manufacture</td>
<td></td>
</tr>
<tr>
<td>1 : Hydraulic</td>
<td>0,42</td>
</tr>
<tr>
<td>2 : Pneumatic</td>
<td>0,15</td>
</tr>
<tr>
<td>3 : Spring</td>
<td>0,09</td>
</tr>
<tr>
<td>4 : Other</td>
<td>0,00</td>
</tr>
<tr>
<td>Total</td>
<td>0,17</td>
</tr>
</tbody>
</table>

[Source: Part 2 - Reliability of High Voltage SF6 Circuit Breakers, Table 2-111]

Modern “hydraulic” show better reliability than “spring”
Statistics (1)
Quantities of HM-types delivered 1986–2016

Reliability highlighted by quantity

- More than 125,000 operating mechanisms
- More than 1.2 million circuit-breaker operating years

[Source: ABB]
HMB reliability
Reflected in Cigré statistic 2012

Dependency on period of manufacture
Diagram shows the frequency of MaF occurring in the period 2004-2007, dependent on the period of manufacture of the equipment.

[Source: Part 2 - Reliability of High Voltage SF6 Circuit Breakers, Table 2-111]

MaF = major failure

Remark: The number for hydraulic in 2004-2007 is zero.

HMB decreases overall failure rate
HMB reliability

Reflected in Cigré statistic 2012

Dependency on type of circuit-breaker

Diagram shows the frequency of MaF occurring in the period 2004-2007, dependent on the type of switchgear.

[Source: Part 2 - Reliability of High Voltage SF6 Circuit Breakers, Table 2-79]

MaF = major failure

Diagram: MaF/100 CB-years

- LTB: Low population of HM types
- DTB: Significant population of HM types
- GIS: Significant population of HM types

HMB decreases failure rate where applied to

Type of CB

- spring
- hydraulic
Summary and conclusions
Subtitle

**The Cigré study**

- The study is based on the returned data of 91 utilities from 28 different countries.
- The Cigré study has no separate category for operating mechanisms like HM type (without external piping and springs), but it includes them in classic „hydraulic“ (with external piping and gas tank).

**Conclusions**

- Modern hydraulic mechanisms (from the period 1999→2007) show a better MaF frequency (0,07→0,00) than spring type mechanisms (0,11→0,06).
- ABB’s HM types are in the market since the mid 90s leading to the reduction of MaF frequency of hydraulic types.
- Distribution of MaF dependent on the type of switchgear (population low in LTB, but high in DTB and GIS) further supports this conclusion.
Additional information
Categories for operating mechanisms in the report

**Mechanisms**

**Hydraulic (may include springs)**
Operating mechanism where the force for opening or closing operation, or both, is generated by hydraulic pressure. Springs may be used for opening operations in case of hydraulic closing operations, or for closing operations in case of hydraulic opening operations.

**Pneumatic (may include springs)**
Operating mechanism where the force for opening or closing operation, or both, is generated by pneumatic pressure. Springs may be used for opening operations in case of pneumatic closing operations, or for closing operations in case of pneumatic opening operations.

**Spring**
Operating mechanism where the force for opening and closing operations is generated solely by springs.

**Other (magnetic, motor, etc.)**
Operating mechanism where the force for opening and closing operations is generated by other means than hydraulic or pneumatic pressure or springs. Examples are magnetic actuators, or directly connected electric motors.